PL-TR-92-2077

THE ELECTRODYNAMICS OF THE DAYSIDE CLEFT REGION BASED ON GROUND OBSERVATIONS AT SVALBARD

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31 January 1992

Scientific Report No. 2

PHILLIPS LABORATORY
AIR FORCE SYSTEMS COMMAND
HANSCOM AIR FORCE BASE, MASSACHUSETTS 01731-5000

"This technical report has been reviewed and is approved for publication"

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	31 January 1992	Scientific Report No. 2

4. TITLE AND SUBTITLE
The Electrodynamics of the Dayside Cleft Region Based on Ground Observations at Svalbard

5. FUNDING NUMBERS
PE 61102F
PR 2310 TA G9 WU AN

Grant AFOSR-90-0082

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8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
European Office of Aerospace Research & Development
P.O. Box 14
FPO New York 09510-0200

Phillips Laboratory
Hanscom AFB, MA 01731

Contract Manager: Ed Weber/GPIS

10. SPONSORING/MONITORING AGENCY REPORT NUMBER
PL-TR-92-2077

11. SUPPLEMENTARY NOTES
This is a continuation and extention of the first technical report

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

Svalbard is the Arctic archipelago between 10° and 35° East and 74° and 81° North. The geomagnetic latitude spans from approximately 71° to 77° north. This makes Svalbard an ideal place for studies of dayside aurora and processes in the magnetospheric boundary regions. Conjugacy to stations in Antarctica makes Svalbard even more attractive. The observatory at Ny-Ålesund is the master station in a network which also includes field stations at Longyearbyen, Hopen, Hornsund, Bjørnøya, and Jan Mayen. International cooperation is essential in this programme. Several papers have been presented and many lectures given related to this program. Possible generation mechanisms of dayside cusp auroras including magnetic merging, external pressure pulses and dynamo processes by intruding plasma elements are discussed.

14. SUBJECT TERMS		15. NUMBER OF PAGES
Ground based observations Dayside aurora Cusp	Cleft Polar ionosphere Boundary regions/layers	10 16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	SAR

1. INTRODUCTION

Svalbard is the Arctic archipelago between 10° and 35° East and 74° and 81° North. The geomagnetic latitude spans from approximately 71° to 77° North. The high geographic latitude at a geomagnetic latitude of 75°, makes Svalbard an ideal place for studies of dayside aurora and processes in the magnetospheric boundary regions. Conjugacy to stations in Antarctica makes Svalbard even more attractive.

The observatories at Ny-Ålesund and Longyearbyen are the master stations in a netword which also includes field stations at Hopen, Hornsund, Bjørnøya, and Jan Mayen. The core instruments are photometers, optical imagers, magnetometers and riometers. A detailed list of the ground based instrumentation at the different stations as well as geomagnetic and geographic coordinates for these sites were included in the First Annual Technical Report. The separation between neighbour stations ranges within 110-250 km.

The administrative centre at Svalbard is Longyearbyen, which has a population of approximately 1000. Considering the high latitude of Svalbard, the climate is remarkably mild, in particular in the western regions. The mean temperature in Longyearbyen for March (coldest) is - 14°C, and for July (warmest) + 6°C. The sun is more than 6° below the horizon in Longyearbyen from the end of October till the end of January.

OBSERVATION AND RESEARCH PROGRAMME AT SVALBARD DURING THIS REPORT PERIOD

The observation programme in this joint cooperation between Ionospheric Effects Division at Phillips Laboratory (Coordinator Dr. E. Weber), Hanscom AFB, Bedford, MA and The Group of Cosmical Physics at the University of Oslo, Norway, is concentrated on the electrodynamics and the spectral variation of the dayside cusp and cleft aurora. The main measurements are carried out with multichannel, meridian scanning photometers and advanced, optical imagers at different wavelengths.

During the contract period the following "campaigns" - where our Svalbard optical observations have been of prime importance - have been carried out:

a. A special EISCAT selected program for comparing ion drifts and the dynamics of dayside aurora,
b. EISCAT - common program (CP4); Dec. and Jan. 1991.
c. Selected events coordinated with the satellites DMSP, F-7 and 9, EXOS D and a rocket launched from Andøya Rocket range (Northern Norway) to study F-region aurora.

As seen from the enclosed copy of the Observation Protocol (Appendix I) the most interesting dayside cusp events are listed. Some of these data are now studied in detail and compared with other relevant space and ground based observations.

The optical auroral data are extensively used as a basis for the study of the dynamics and fine structures of the magnetopause boundary layers. Of main importance in this respect is the location of the various optical events in relation to the major particle precipitation boundaries and the large-scale ionospheric ion drift pattern. However, the main features of the aurora may not in all respect point directly to the boundaries and separatrices of importance to the study of the magnetosphere. A careful study of coordinated satellite and ground-based data is therefore required to search for more subtle sign of the boundaries we need to observe.

Coordinated ground-based and satellite observations are required in order to study the connection between the dayside forms, the acceleration regions and the region of plasma entry. The problem of pulsed magnetopause reconnection, flux transfer events and their manifestations at different levels in the magnetosphere and in the ionosphere is still a central subject.

As seen from the enclosed list of publicaations and lectures given, the Group members have been very active during the report period. Ground based auroral structures and dynamics from Svalbard have been compared with simultaneous measurements of energentic electron and ion precipitation as well as horizontal plasma drifts. Intense brightening and drift (sun and anti-sunward) of discrete auroral forms may be connected with external dynamic pressure variations, associated magnetopause perturbations and fundamental modes of magnetosphere - ionosphere coupling, such as kinetic Alfvén waves.

Automatic classification schemes have been applied to the DMSP-precipitation data, in order to statistical identify the particle source regions, such as the central plasma sheet, the boundary plasma sheet, the plasma mantle and polar rain. However, our observations often need alternative interpreta-tions. Several possible generation mechanisms for auroral forms, occurring near magnetic noon, during different IMF conditions are possible. These include magnetic merging poleward of the cusp, variations in the solar wind pressure and dynamo processes in the low - and high-latitude boundary layers of the magnetosphere, powered by intruding plasma elements.

PROGRAM FOR 1992

The observations from Svalbard will continue in the polar night periods in January and November/December 1992. Coordination with EISCAT in January is planned. Furthermore, the future studies will be extended to include nightside phenomena.

We are also continuously working to improve the observation technique and the routines for data reduction. A combined hardware/software system for analysis of TV images has thus

been developed. A new data logging system with modem connection to our laboratories in Oslo will be installed in 1992. This will provide more direct access to the photometer and magnetic data. During the winter 1991/92, an advanced digital ionosonde (with large antennas) together with satellite scintillation receivers have been installed and are now in operation at Ny Ålesund.

Both instruments come from The Ionospheric Effect Division at Phillips Laboratory, Hanscom AFB. Jürgen Buchau is responsible for the ionosonde while Santi Basu controls the scintillation measurements. Both these instruments are part of a larger net, with several identical set-ups in Greenland. By combining these new observations with existing instrumentations, it is possible to study the electron density in the polar ionosphere in great details, as well as the dynamics of the ionosphere including the drift of patches. From detailed spectral studies of the scintillation measurements it is possible to determine which instability machanism is responsible for the irregularities in the polar cusp and cap. These new parameters will be of great importance for understanding the physics of the boundary layer processes. Department of Physics at the University of Oslo will be responsible for the operation of these new instruments.

EXCANGE OF SCIENTISTS BETWEEN THE TWO INSTITUTIONS

We have had a close contract with the program manager for this contract, Dr. Edward J. Weber, during this period.

The project scientist spent six months at Phillips Laboratory (January to July, 1991). Several papers from this visit will soon appear. Dr. H. Carlson, the Deputy Division Director at Ionospheric Effects Division, Hanscom AFB, visited us in Oslo in April and September. He also served as an external Ph.D. examinator for a doctor thesis on Cusp Aurora at the University of Oslo in April 1991.

One of the young members of our Group - research assistant Jøran Moen - spent one month (September 1991) at Ionospheric Effects Division, Philips Laboratory.

PUBLICATIONS/REPORTS

The following papers/reports, pertinent to this contract, have been published during the contract period:

Carlson, H. and A. Egeland: The Polar Aurora. A chapter to a new textbook at University of California, LA, in Space physics (Kivelson and Russell, eds.)

Denig, W.F., W.J. Burke, N.C. Maynard, F.J. Rich, B. Jacobsen, P.E. Sandholt, A. Egeland, S. Leontjev, and V.G. Vorobjev: Ionospheric signatures of dayside magnetopause transients: A case study using satellite and ground measurements, J. Geophys. Res., in press 1992.

Egeland, A., H.C. Carlson, W.F. Denig, K. Fukui, E. Weber: Dayside Auroral Signatures Based on Simultaneous, Coordinated Observations at Svalbard and Greenland, To appear in IEEE Transactions on Plasma Science; Third Special Issue (1992).

Holtet, J.A. and A. Brekke: The Norwegian Upper Atmosphere Programme in Svalbard, in: Proceedings from the ESA-workshop at Longyearbyen, Svalbard, September 1991.

Jacobsen, B., P.E. Sandholt; B. Lybekk, and A. Egeland: Transient auroral events near midday: Relationship with solar wind/magnetosheath plasma and magnetic field conditions, J. Geophys. Res., 96, 1327, 1991.

Pudovkin, M.I., S.A. Zaitseva, P.E. Sandholt, and A. Egeland: Dynamics of aurora in the cusp region and characteristics of magnetic reconnection at the magnetopause, Planet. Space Sci., in press 1991.

Sandholt, P.E.: Auroral electrodynamics at the cusp/cleft poleward boundary during northward interplanetary magnetic field, Geophys. Res. Lett., 18, 805, 1991.

Sandholt, P.E. and P.T. Newell: Ground and satellite observations of an auroral event at the cusp/cleft equatorward boundary, J. Geophys. Res., in press 1991.

Sandholt, P.E., M. Lockwood, W.F. Denig, R.C. Elphic, and S. Leontjev: Dynamical auroral structure in the vicinity of the polar cusp: Multipoint observations during southward and northward IMF, Ann. Geophys., in press 1992.

CONFERENCE CONTRIBUTIONS:

Papers based on cusp/cleft/cap observations at Svalbard were during 1991 presented at the following international meetings:

a) The AGU Spring Meeting, Baltimore, MD.

b) The European Geophysical Society Meeting, Wiesbaden, Germany.

c) The IAGA Assembly Meeting in Vienna, Austria, and

d) The annual Nordic Workshop on Upper Atmosphere Physics, Denmark.

APPENDIX I: Observation Programme

Best periods from Ny Ålesund in the December 1990 campaign
(clear sky and moderate to strong auroral activity)

December 6 to 15 UT

December 7 all day

December 8 to 08 UT

December 11 to 0530 UT

December 13 0630 to 0930

December 16 to 09 UT

December 18 from 09 UT

December 20 0730 to 0910 UT (possibly longer).

Operators: Bjørn Jacobsen and Dagfinn Opsvik

Best periods from Ny Ålesund January 1991 campaign

January 8 from 14 UT

January 9 all day

January 10 all day

January 11 all day

January 12 all day

Operators: Jan Holtet, P.E. Sandholt and several graduate students